PATENT ABSTRACTS OF JAPAN

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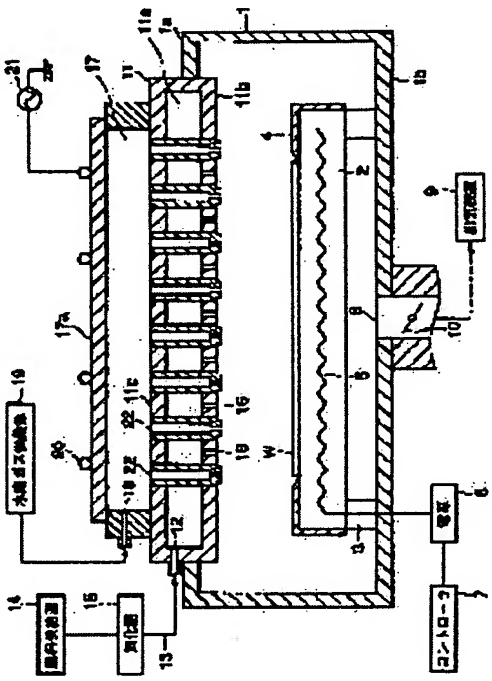
(54) FILM FORMING DEVICE AND FORMATION OF FILM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a film forming device capable of forming a metallic film of high film quality at a high film forming rate without giving damage to the body to be treated and to provide a film forming method.
SOLUTION: This film forming device is formed of a chamber I to be stored with a semiconductor wafer W, an organometallic compd. feeding system 15 feeding an organometallic compd. to the inside of the chamber I, a plasma generating chamber 17 provided separately from.? the chamber I, a plasma generating means 21 applying the electric field to the plasma generating chamber 17 and plasmatizing hydrogen introduced into the plasma generating chamber 17, many hydrogen radical introducing passages 22 introducing hydrogen radicals from the plasma generating chamber 17 into the chamber and a heating means 5 heating a semiconductor wafer W, decomposing the organometallic compd. and depositing a metallic film on the semiconductor wafer W. The inner wall of the hydrogen radical introducing passage 22 is formed of an insulating member to prevent the dissipation of the hydrogen radicals.



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CLAIMS

[Claim(s)]
[Claim 1] Membrane-formation equipment characterized by to provide the chamber which holds a processed object, the organometallic compound supply system which supplies an organometallic compound into said chamber, a plasma production means form the plasma of hydrogen, the device which introduces a hydrogen radical into said chamber alternatively from the plasma of the formed hydrogen, and a heating means heat said processed object, make said organometallic compound disassemble, and make a processed object deposit a metal membrane.
[Claim 2] The chamber which holds a processed object, and the organometallic compound supply system which supplies an organometallic compound into said chamber, The plasma production room prepared separately from said chamber, and the hydrogen supply system which supplies hydrogen to said plasma production room, A plasma production means to plasma-ize the hydrogen which impressed electric field to said plasma production room, and was introduced into the plasma production room, The hydrogen radical installation way which leads a hydrogen radical to said chamber from said plasma production room, It is membrane formation equipment which heats said processed object, is made to disassemble said organometallic compound, possesses a heating means to make a processed object deposit a metal membrane, and is characterized by forming the wall of said hydrogen radical installation way with the insulator.
[Claim 3] It is membrane formation equipment according to claim 2 characterized by said organometallic compound supply system being prepared in the upper part of said chamber, having the shower head which has the introductory hole which introduces an organometallic compound into said chamber, and said plasma production room being prepared above said chamber, and for said hydrogen radical installation way penetrating said shower head, and preparing it from said plasma production room.
[Claim 4] Said hydrogen radical installation way is membrane formation equipment according to claim 3 characterized by having the through tube which penetrates said shower head, and the tubed insulating member inserted in the through tube.
[Claim 5] Said hydrogen radical installation way is membrane formation equipment given in any 1 term of claim 2 characterized by being formed so that the opening area by the side of a chamber may become small rather than the opening area by the side of a plasma production room thru/or claim 4.
[Claim 6] The membrane-formation approach which forms the process which supplies the organometallic compound evaporated into the chamber which holds a processed object, and the plasma of hydrogen, and is characterized by providing the process which adds a hydrogen radical from the plasma of the formed hydrogen to said organometallic compound alternatively, and the process on which heat said processed object, said organometallic compound is made to disassemble into, and a processed object is made to deposit a metal membrane.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the membrane formation equipment and the membrane formation approach of forming a metal membrane using an organometallic compound.
[0002]
[Description of the Prior Art] In manufacture of LSI, although wiring is formed on semi-conductor wafers, such as silicon, as wiring of such LSI, aluminum and Cu are used and these are conventionally formed by mainly forming membranes by the sputtering method.
[0003] However, in current [to which detailed-ization of wiring is progressing], and sputtering, it is becoming difficult to obtain wiring of the detailed-ized level demanded. for this reason, CVD (Chemical Vapor Deposition) which can respond to detailed-ization -- forming wiring using law is called for and various examination is made.
[0004] Organocopper compounds, such as for example, Cu(hfac) TMVS and Cu(hfac) ATMS, are used as a membrane formation raw material, this is made to evaporate with a carburetor and it supplies in a chamber, and you make it deposit Cu by which the organocopper compound was generated by decomposing on it, in forming Cu wiring by CVD, heating the semi-conductor wafer arranged in a chamber.
[0005] However, in forming Cu film with such heat CVD, a membrane formation rate is slow and there is a trouble that productivity is low.
[0006] As a technique which solves the trouble that such productivity is low, it faces supplying an organometallic compound and carrying out CVD membrane formation of the metals, such as Cu, and the technique which forms membranes while supplying a hydrogen atom or a hydrogen radical to a membrane formation side and promoting a reaction is indicated by JP,6-158320,A, and in order to generate a hydrogen radical, the plasma generator is used here.
[0007]
[Problem(s) to be Solved by the Invention] However, like JP,6-158320,A, when the plasma of hydrogen is formed with a plasma generator, there is a possibility of charged particles, such as a hydrogen ion besides a hydrogen radical and an electron, also being generated, colliding with the semi-conductor wafer these [whose] are the candidates for membrane formation, and giving a damage.
[0008] Moreover, although the front face of the film which formed membranes is ruined or there is also a problem in the membraneous side that specific resistance is high, with the technique which forms a metal membrane using the conventional organometallic compound, it is difficult to fully solve the problem of such a membraneous side with the above-mentioned technique.
[0009] This invention is made in view of this situation, and it aims at offering the membrane formation equipment and the membrane formation approach of forming the metal membrane of good membraneous quality at a high membrane formation rate by CVD, without giving a damage to a processed object.
[0010]
[Means for Solving the Problem] The chamber which holds a processed object according to the 1st viewpoint of this invention in order to solve the above-mentioned technical problem, The organometallic compound supply system which supplies an organometallic compound into said

chamber, A plasma production means to form the plasma of hydrogen, and the device which introduces a hydrogen radical into said chamber alternatively from the plasma of the formed hydrogen, Heat said processed object, said organometallic compound is made to disassemble, and the membrane formation equipment characterized by providing a heating means to make a processed object deposit a metal membrane is offered.

[0011] Moreover, the chamber which holds a processed object according to the 2nd viewpoint of this invention, The organometallic compound supply system which supplies an organometallic compound into said chamber, The plasma production room prepared separately from said chamber, and the hydrogen supply system which supplies hydrogen to said plasma production room, A plasma production means to plasma-ize the hydrogen which impressed electric field to said plasma production room, and was introduced into the plasma production room, The hydrogen radical installation way which leads a hydrogen radical to said chamber from said plasma production room, Heat said processed object, said organometallic compound is made to disassemble, a heating means to make a processed object deposit a metal membrane is provided, and the membrane formation equipment characterized by forming the wall of said hydrogen radical installation way with the insulator is offered.

[0012] In this case, said organometallic compound supply system is prepared in the upper part of said chamber, it has the shower head which has the introductory hole which introduces an organometallic compound into said chamber, and said plasma production room is prepared above said chamber, and said hydrogen radical installation way can be constituted as said shower head is penetrated and it is prepared from said plasma production room. The structure of having the through tube which penetrates said shower head, and the tubed insulating member inserted in the through tube can be used for said hydrogen radical installation way. As for said hydrogen radical installation way, it is more desirable than the opening area by the side of a plasma production room to be formed so that the opening area by the side of a chamber may become small.

[0013] Furthermore, the process which supplies the organometallic compound which was evaporated into the chamber which holds a processed object according to the 3rd viewpoint of this invention, The process which forms the plasma of hydrogen and adds a hydrogen radical from the plasma of the formed hydrogen to said organometallic compound alternatively, Heat said processed object, said organometallic compound is made to disassemble, and the membrane formation approach characterized by providing the process on which a processed object is made to deposit a metal membrane is offered.

[0014] In this invention, introduce an organometallic compound into a chamber, and by heating the processed object in a chamber, disassemble an organometallic compound and it faces forming a metal membrane on a processed object. Since a hydrogen radical is alternatively introduced into said chamber from the plasma of the hydrogen formed out of the chamber While being able to form a metal membrane at a high membrane formation rate according to the reaction promotion operation by the hydrogen radical, a good metal membrane can be obtained without receiving the damage by charged particles, such as a hydrogen ion and an electron.

[0015] Specifically a plasma production room is prepared separately from said chamber, electric field are impressed to a plasma production room like the 2nd viewpoint of the above, the plasma of hydrogen is formed in it, it faces leading a hydrogen radical to a chamber from a plasma production room by the hydrogen radical installation way, and the wall of a hydrogen radical installation way is formed with an insulator. Thereby, to a charged particle being attracted by the part which functions as a counterelectrode of the plasma production interior of a room, and disappearing, a neutral radical goes straight on, without being drawn in, and reaches a hydrogen radical installation way. In this case, since the wall of a hydrogen radical installation way is formed with the insulator, it is introduced into a chamber, without a hydrogen radical disappearing. That is, a hydrogen radical is alternatively introduced into a chamber.

[0016]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail with reference to an accompanying drawing. Drawing 1 is the sectional view showing the CVD membrane formation equipment which takes like 1 operative condition as for this invention. This membrane formation equipment forms Cu by CVD, and has the chamber 1 constituted possible

[nothing and evacuation] in approximate circle tubed. In the chamber 1, the susceptor 2 for supporting horizontally the semi-conductor wafer W which is a processed object is arranged, after having been supported by the supporter material 3. The guide ring 4 for guiding the semi-conductor wafer W is formed in the rim section of a susceptor 2. Moreover, the heater 5 is embedded at the susceptor 2 and this heater 5 heats the semi-conductor wafer W which is a processed object to predetermined temperature by supplying electric power from a power source 6. The controller 7 is connected to the power source 6, and the output of a heater 5 is controlled according to the signal of the thermo sensor which this does not illustrate.

[0017] The exhaust air port 8 is formed in bottom wall 1b of a chamber 1, and the exhauster 9 is connected to this exhaust air port 8. The inside of a chamber 1 can be decompressed to a predetermined degree of vacuum with an exhauster 9. Moreover, the automatic pressure control valve 10 for controlling displacement automatically is formed in the exhaust air way.

[0018] The shower head 11 is attached in ceiling wall 1a of a chamber 1. The raw material installation port 12 is formed in the side attachment wall of this shower head 11, and piping 13 is connected to it in this raw material installation port 12. The source 14 of feeding is established in the other end of piping 13, the metal copper compound which is a liquid as a membrane formation raw material is sent out from this source 14 of feeding, and this metal copper compound is evaporated with the carburetor 15 prepared in the middle of piping 13, and is introduced in the shower head 11 through the raw material installation port 12. The shower head 11 has space 11a inside, and has many gas discharge openings 16 in low wall 11b. Therefore, the metal copper compound gas introduced into building envelope 11a of the shower head 11 through piping 13 is breathed out towards the semi-conductor wafer W from the gas discharge opening 16.

[0019] Cu(hfac) TMVS or Cu(hfac) ATMS which is the organocopper compound of a liquid is stored by the source 2 of feeding, and a proper means sends out such a liquid raw material to it towards a carburetor 15 through piping 13.

[0020] The plasma production room 17 for forming the hydrogen plasma is formed above the shower head 11. The hydrogen gas installation port 18 is formed in the side attachment wall of this plasma production room 17, and hydrogen gas is introduced into the plasma production room 17 through the hydrogen gas installation port 18 from the source 19 of hydrogen gas supply.

[0021] The curled form antenna 20 is formed on upper wall 17a of the plasma production room 17, and RF generator 21 is connected to this antenna 20. And by supplying a 13.56MHz RF to an antenna 20 from this RF generator 21, RF electric field are formed in the plasma formation room 17, and, thereby, the plasma of hydrogen gas is formed.

[0022] As for the plasma production room 17, many hydrogen radical installation ways 22 are formed so that the bottom wall may consist of upper wall 11c of the above-mentioned shower head 11 and may penetrate low wall 11b from upper wall 11c of the shower head 11. And only a hydrogen radical is introduced in a chamber 1 through the hydrogen radical installation way 22 out of the plasma generated at the plasma production room 17.

[0023] As specifically shown in drawing 2 , the cylinder part material 23 of a large number which penetrate the shower head 11 up and down is formed, the tubed insulating member 24 which consists of a ceramic ingredient is inserted in the interior, and the hydrogen radical installation way 22 is formed inside the insulating member 24. Flange 24a is formed in the upper limit of an insulating member 24. As for the lower limit of the hydrogen radical installation way 22, i.e., chamber side opening, the narrow diameter portion 25 is formed so that opening area may become small rather than plasma production room side opening of upper limit. By this configuration, while being able to incorporate a hydrogen radical efficiently from a plasma production room, the back diffusion of a hydrogen radical can be prevented.

[0024] In addition, for the path of upper limit opening of 25mm and the hydrogen radical installation way 22, the path of 5mm and a narrow diameter portion 25 is [the thickness of the shower head 11 / spacing of 0.5-1mm and hydrogen radical installation way 22 comrades of the dimension in this case] 20mm.

[0025] Moreover, although the perimeter of the inlet port (plasma production room side opening) of the hydrogen radical installation way 22 is formed with the insulating material (flange 24a), the conductor (for example, aluminum) which constitutes shower head upper wall 11c is exposed to the

clearance between the adjoining flanges.
[0026] In the base of the shower head 11, chamber side opening of the gas delivery 16 and the hydrogen radical installation way 22 is arranged concentric circular [two or more] or in the shape of a matrix so that it may become at equal intervals mostly, respectively. Furthermore, both are stationed so that spacing may be buried mutually, and they are introduced into homogeneity in a chamber with material gas (organocopper compound) and a hydrogen radical.
[0027] Thus, it faces forming Cu film in the membrane formation equipment constituted, and first, the semi-conductor wafer W is carried in in a chamber 1, and it lays on a susceptor 2. And decompressing the inside of a chamber 1 with an exhauster 9, the material gas which gasified the organocopper compound raw material of the shape of a liquid from the source 14 of feeding with the carburetor 15 is introduced in the shower head 11 through the raw material installation port 12, and it introduces into a chamber 1 from many gas discharge openings 16.
[0028] On the other hand, introducing hydrogen gas from the source 19 of hydrogen gas supply in the plasma production room 17, a RF is impressed to an antenna 20 from RF generator 21, and installation and coincidence of the above-mentioned organocopper compound raw material are made to generate the plasma of hydrogen gas in the plasma production room 17.
[0029] Although the hydrogen ion and electron which are a charged particle are attracted by the surface part of upper wall 11c of the shower head 11 which functions as a counterelectrode and it disappears as it is shown in drawing 3 , although the hydrogen ion, the electron, and the hydrogen radical live together in the plasma, the hydrogen radical which is neutrality goes straight on, and the hydrogen radical of the part corresponding to the hydrogen radical installation way 22 is introduced in a chamber through the hydrogen radical installation way 22. Therefore, only a hydrogen radical is alternatively introduced in a chamber 1 in the plasma of hydrogen gas. In this case, since the wall of the hydrogen radical installation way 22 is an insulating member 24, it is introduced into a chamber 1, without a hydrogen radical disappearing. Moreover, since the point of the hydrogen radical installation way 22 is a narrow diameter portion 25, the back diffusion of a hydrogen radical is prevented and it can prevent that a hydrogen radical is collided and exhausted on the inferior surface of tongue of the shower head 11.
[0030] If the material gas which consists of organocopper compounds, such as Cu(hfac) TMVS and Cu(hfac) ATMS, is supplied in a chamber 1 as mentioned above, since the semi-conductor wafer W is heated at the heater 5 laid underground in the susceptor 2 more than the decomposition temperature of material gas, material gas will be decomposed in the front face of the semi-conductor wafer W, and Cu film will be formed on the semi-conductor wafer W.
[0031] The hydrogen radical supplied in the chamber 1 as mentioned above on the occasion of this membrane formation promotes decomposition reactions, such as Cu(hfac) TMVS and Cu(hfac) ATMS. Therefore, a membrane formation rate rises by existence of a hydrogen radical, and Cu film can be formed efficiently. Thus, it is because that a reaction is promoted by the hydrogen radical can also make Cu component which is not decomposed to Cu and does not contribute to membrane formation able to decompose when not using a hydrogen radical, and it can consider as a membrane component.
[0032] Moreover, since a reaction is promoted by introducing a hydrogen radical in this way, it becomes possible to form membranes at low temperature more. That it specifically needed to heat at about 190 degrees C when membranes were conventionally formed using Cu(hfac) TMVS or Cu (hfac) ATMS can make it fall to about 170 degrees C by introducing a hydrogen radical. Thus, the problem of the specific resistance rise by the migration produced when the thickness of Cu film was thin is solvable conventionally that low-temperature membrane formation is possible.
[0033] Furthermore, since only a hydrogen radical can be alternatively introduced in a chamber 1 in this way, formed Cu film can prevent receiving a damage by charged particles, such as a hydrogen ion and an electron. Therefore, Cu film of good membraneous quality can be obtained.
[0034] In addition, this invention is variously deformable, without being limited to the above-mentioned operation gestalt. For example, with the above-mentioned operation gestalt, although Cu (hfac) TMVS or Cu(hfac) ATMS was used as a Cu raw material, it does not restrict to this.
[0035] Moreover, although the case where this invention was applied to CVD membrane formation of Cu was shown, the candidate for membrane formation is applicable if not only Cu but aluminum

etc. not necessarily performs CVD by using an organometallic compound as a raw material. The approach of forming the hydrogen plasma is not restricted to an above-mentioned approach, either.
[0036] Furthermore, although the semi-conductor wafer was used as a processed object with the above-mentioned operation gestalt, not only this but a LCD substrate etc. should just be the object in which a metal membrane is formed by CVD.
[0037]
[Effect of the Invention] As stated above, according to this invention, an organometallic compound is introduced into a chamber. By heating the processed object in a chamber, disassemble an organometallic compound and it faces forming a metal membrane on a processed object. Since a hydrogen radical is alternatively introduced into said chamber from the plasma of the hydrogen formed out of the chamber and it adds to an organometallic compound While being able to form a metal membrane at a high membrane formation rate according to the reaction promotion operation by the hydrogen radical, a good metal membrane can be obtained without receiving the damage by charged particles, such as a hydrogen ion and an electron.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The sectional view showing the CVD membrane formation equipment concerning 1 operation gestalt of this invention.
[Drawing 2] The sectional view expanding and showing the arrangement part of the hydrogen radical installation way of the equipment shown in drawing 1 .
[Drawing 3] The sectional view expanding and showing the arrangement part of a hydrogen radical installation way in order to explain the principle by which hydrogen radical chisel installation is carried out from a plasma production room to a chamber.
[Description of Notations]
1 .... Chamber
2 .... Susceptor
5 .... Heater
11 .... Shower head
14 .... Source of feeding
17 .... Hydrogen plasma production room
21 .... RF generator (plasma production means)
22 .... Hydrogen radical installation way
23 .... Insulating member
W .... Semi-conductor wafer

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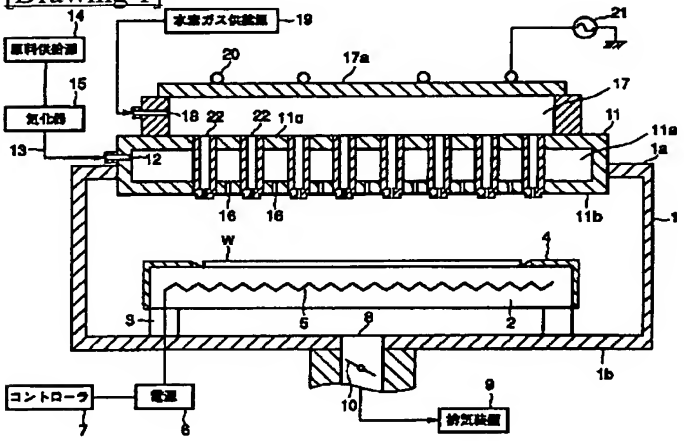
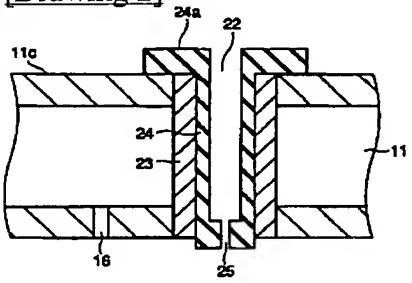
DRAWINGS

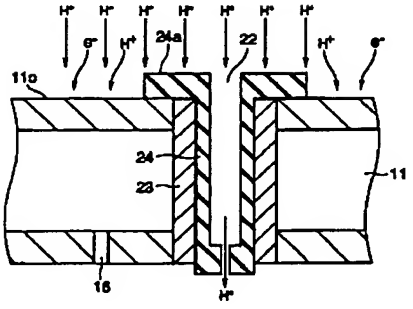
[Drawing 1]



[Drawing 2]



[Drawing 3]



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CORRECTION OR AMENDMENT

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[Procedure revision]
[Filing Date] August 23, Heisei 17 (2005. 8.23)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] The name of invention
[Method of Amendment] Modification
[The contents of amendment]
[Title of the Invention] Membrane formation equipment
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[The contents of amendment]
[Claim(s)]
[Claim 1]
The chamber which holds a processed object,
The material gas supply system equipped with the shower head which has the introductory hole which is prepared in the upper part of said chamber and introduces material gas into said chamber,
The plasma production room prepared above said chamber,
A plasma production means to plasma-ize the gas which impressed electric field to said plasma production room, and was introduced into the plasma production room,
It has the radical installation way which introduces a radical into said chamber alternatively from the plasma of said plasma production room,
Said radical installation way is membrane formation equipment characterized by penetrating said

shower head and being prepared from the plasma production room.
[Claim 2]
Said radical installation way is membrane formation equipment according to claim 1 characterized by having the through tube which penetrates said shower head, and the tubed insulating member inserted in the through tube.
[Claim 3]
Said radical installation way is membrane formation equipment according to claim 1 or 2 characterized by being formed so that the opening area by the side of a chamber may become small rather than the opening area by the side of a plasma production room.
[Procedure amendment 3]
[Document to be Amended] Specification
[Item(s) to be Amended] 0001
[Method of Amendment] Modification
[The contents of amendment]
[0001]
[Field of the Invention]
This invention relates to the membrane formation equipment which forms a metal membrane by CVD.
[Procedure amendment 4]
[Document to be Amended] Specification
[Item(s) to be Amended] 0009
[Method of Amendment] Modification
[The contents of amendment]
[0009]
This invention is made in view of this situation, and it aims at offering the membrane formation equipment which can form the metal membrane of good membraneous quality at a high membrane formation rate by CVD, without giving a damage to a processed object.
[Procedure amendment 5]
[Document to be Amended] Specification
[Item(s) to be Amended] 0010
[Method of Amendment] Modification
[The contents of amendment]
[0010]
[Means for Solving the Problem]
The chamber which holds a processed object according to this invention in order to solve the above-mentioned technical problem,
The material gas supply system equipped with the shower head which has the introductory hole which is prepared in the upper part of said chamber and introduces material gas into said chamber,
The plasma production room prepared above said chamber,
A plasma production means to plasma-ize the gas which impressed electric field to said plasma production room, and was introduced into the plasma production room,
It has the radical installation way which introduces a radical into said chamber alternatively from the plasma of said plasma production room,
The membrane formation equipment characterized by for said radical installation way penetrating said shower head, and preparing it from the plasma production room is offered.
[Procedure amendment 6]
[Document to be Amended] Specification
[Item(s) to be Amended] 0011
[Method of Amendment] Deletion
[The contents of amendment]

[Procedure amendment 7]
[Document to be Amended] Specification
[Item(s) to be Amended] 0012
[Method of Amendment] Modification

[The contents of amendment]
[0012]
In this case, the structure of having the through tube which penetrates said shower head, and the tubed insulating member inserted in that through tube can be used for said radical installation way. As for said radical installation way, it is more desirable than the opening area by the side of a plasma production room to be formed so that the opening area by the side of a chamber may become small.
[Procedure amendment 8]
[Document to be Amended] Specification
[Item(s) to be Amended] 0013
[Method of Amendment] Deletion
[The contents of amendment]

[Procedure amendment 9]
[Document to be Amended] Specification
[Item(s) to be Amended] 0014
[Method of Amendment] Modification
[The contents of amendment]
[0014]
In this invention, since a radical is alternatively introduced into said chamber from the plasma formed out of the chamber, while being able to form a metal membrane at a high membrane formation rate according to the reaction promotion operation by the radical, a good metal membrane can be obtained, without receiving the damage by charged particles, such as ion and an electron.
[Procedure amendment 10]
[Document to be Amended] Specification
[Item(s) to be Amended] 0015
[Method of Amendment] Modification
[The contents of amendment]
[0015]
Specifically a plasma production room is prepared separately from said chamber, electric field are impressed to a plasma production room, the plasma is formed in it, and a radical is led to a chamber from a plasma production room by the radical installation way. In this case, by forming the wall of a radical installation way with an insulator, to a charged particle being attracted by the part which functions as a counterelectrode of the plasma production interior of a room, and disappearing, a neutral radical goes straight on, without being drawn in, and reaches a radical installation way. In this case, since the wall of a radical installation way is formed with the insulator, it is introduced into a chamber, without a radical disappearing. That is, a radical is alternatively introduced into a chamber.
[Procedure amendment 11]
[Document to be Amended] Specification
[Item(s) to be Amended] 0037
[Method of Amendment] Modification
[The contents of amendment]
[0037]
[Effect of the Invention]
Since a radical is alternatively introduced into said chamber from the plasma formed out of the chamber according to this invention as stated above, while being able to form a metal membrane at a high membrane formation rate according to the reaction promotion operation by the radical, a good metal membrane can be obtained without receiving the damage by charged particles, such as ion and an electron.

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16/455		16/44	Ｄ	４Ｍ１０４
Ｈ０１Ｌ　21/285		Ｈ０１Ｌ　21/285	Ｃ	

審査請求　未請求　請求項の数６　ＯＬ　（全６頁）

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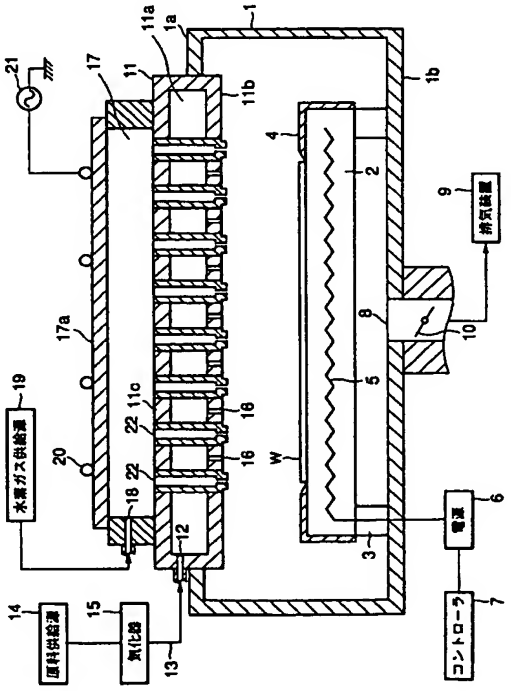
(54)【発明の名称】　成膜装置および成膜方法

(57)【要約】
【課題】　被処理体にダメージを与えることなく良好な膜質の金属膜を高い成膜速度で形成することができる成膜装置および成膜方法を提供すること。
【解決手段】　半導体ウエハＷを収容するチャンバー１と、チャンバー１内へ有機金属化合物を供給する有機金属化合物供給系１４と、チャンバー１とは別個に設けられたプラズマ生成室１７と、プラズマ生成室に水素を供給する水素供給系１９と、プラズマ生成室１７に電界を印加してプラズマ生成室１７に導入された水素をプラズマ化するプラズマ生成手段２１と、プラズマ生成室１７から前記チャンバーへ水素ラジカルを導く多数の水素ラジカル導入路２２と、半導体ウエハＷを加熱して有機金属化合物を分解させ、半導体ウエハＷに金属膜を堆積させる加熱手段５とから成膜装置が形成される。水素ラジカル導入路２２の内壁は絶縁部材２３で形成されており、水素ラジカルの消滅が防止される。



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【特許請求の範囲】
【請求項１】　被処理体を収容するチャンバーと、
前記チャンバー内へ有機金属化合物を供給する有機金属化合物供給系と、
水素のプラズマを形成するプラズマ生成手段と、
形成された水素のプラズマから水素ラジカルを選択的に前記チャンバーに導入する機構と、
前記被処理体を加熱して前記有機金属化合物を分解させ、被処理体に金属膜を堆積させる加熱手段とを具備することを特徴とする成膜装置。
【請求項２】　被処理体を収容するチャンバーと、
前記チャンバー内へ有機金属化合物を供給する有機金属化合物供給系と、
前記チャンバーとは別個に設けられたプラズマ生成室と、
前記プラズマ生成室に水素を供給する水素供給系と、
前記プラズマ生成室に電界を印加してプラズマ生成室に導入された水素をプラズマ化するプラズマ生成手段と、
前記プラズマ生成室から前記チャンバーへ水素ラジカルを導く水素ラジカル導入路と、
前記被処理体を加熱して前記有機金属化合物を分解させ、被処理体に金属膜を堆積させる加熱手段とを具備し、
前記水素ラジカル導入路の内壁は絶縁体で形成されていることを特徴とする成膜装置。
【請求項３】　前記有機金属化合物供給系は、前記チャンバーの上部に設けられ、前記チャンバー内へ有機金属化合物を導入する導入孔を有するシャワーヘッドを有し、前記プラズマ生成室は前記チャンバーの上方に設けられ、前記水素ラジカル導入路は前記プラズマ生成室から前記シャワーヘッドを貫通して設けられていることを特徴とする請求項２に記載の成膜装置。
【請求項４】　前記水素ラジカル導入路は、前記シャワーヘッドを貫通する貫通孔と、その貫通孔にはめ込まれた筒状の絶縁部材とを有することを特徴とする請求項３に記載の成膜装置。
【請求項５】　前記水素ラジカル導入路は、プラズマ生成室側の開口面積よりもチャンバー側の開口面積が小さくなるように形成されていることを特徴とする請求項２ないし請求項４のいずれか１項に記載の成膜装置。
【請求項６】　被処理体を収容するチャンバー内へ気化された有機金属化合物を供給する工程と、
水素のプラズマを形成し、形成された水素のプラズマから水素ラジカルを選択的に前記有機金属化合物に添加する工程と、
前記被処理体を加熱して前記有機金属化合物を分解させ、被処理体に金属膜を堆積させる工程とを具備することを特徴とする成膜方法。
【発明の詳細な説明】
【０００１】

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【発明の属する技術分野】本発明は、有機金属化合物を用いて金属膜を形成する成膜装置および成膜方法に関する。
【０００２】
【従来の技術】ＬＳＩの製造においては、シリコン等の半導体ウエハ上に配線を形成するが、このようなＬＳＩの配線としては、ＡｌやＣｕが用いられており、従来これらは主にスパッタリング法により成膜することにより形成されている。
【０００３】しかしながら、配線の微細化が進んでいる現在、スパッタリングでは要求される微細化レベルの配線を得ることが困難となりつつある。このため、微細化に対応可能なＣＶＤ（Chemical Vapor Deposition）法を用いて配線を形成することが求められており、種々の検討がなされている。
【０００４】Ｃｕ配線をＣＶＤで成膜する場合には、例えばＣｕ（ｈｆａｃ）ＴＭＶＳやＣｕ（ｈｆａｃ）ＡＴＭＳ等の有機銅化合物が成膜原料として用いられ、これを気化器により気化させてチャンバー内に供給し、チャンバー内に配置された半導体ウエハを加熱しつつ、その上に有機銅化合物が分解して生成されたＣｕを堆積させる。
【０００５】しかし、このような熱ＣＶＤによりＣｕ膜を形成する場合には、成膜速度が遅く、生産性が低いという問題点がある。
【０００６】このような生産性が低いという問題点を解決する技術として、特開平６－１５８３２０号公報には、有機金属化合物を供給してＣｕ等の金属をＣＶＤ成膜するに際し、成膜面に水素原子または水素ラジカルを供給して反応を促進させながら成膜を行う技術が開示されており、ここでは、水素ラジカルを生成するためにプラズマ発生装置を用いている。
【０００７】
【発明が解決しようとする課題】しかし、特開平６－１５８３２０号公報のように、プラズマ発生装置により水素のプラズマを形成すると、水素ラジカルの他、水素イオンや電子等の荷電粒子も生成され、これらが成膜対象である半導体ウエハに衝突してダメージを与えるおそれがある。
【０００８】また、従来の有機金属化合物を用いて金属膜を成膜する技術では、成膜した膜の表面が荒れていたり、比抵抗が高いといった膜質面での問題もあるが、上記技術ではこのような膜質面の問題を十分に解消することは困難である。
【０００９】本発明はかかる事情に鑑みてなされたものであって、被処理体にダメージを与えることなくＣＶＤにより良好な膜質の金属膜を高い成膜速度で形成することができる成膜装置および成膜方法を提供することを目的とする。
【００１０】

【課題を解決するための手段】上記課題を解決するために、本発明の第１の観点によれば、被処理体を収容するチャンバーと、前記チャンバー内へ有機金属化合物を供給する有機金属化合物供給系と、水素のプラズマを形成するプラズマ生成手段と、形成された水素のプラズマから水素ラジカルを選択的に前記チャンバーに導入する機構と、前記被処理体を加熱して前記有機金属化合物を分解させ、被処理体に金属膜を堆積させる加熱手段とを具備することを特徴とする成膜装置が提供される。

【００１１】また、本発明の第２の観点によれば、被処理体を収容するチャンバーと、前記チャンバー内へ有機金属化合物を供給する有機金属化合物供給系と、前記チャンバーとは別個に設けられたプラズマ生成室と、前記プラズマ生成室に水素を供給する水素供給系と、前記プラズマ生成室に電界を印加してプラズマ生成室に導入された水素をプラズマ化するプラズマ生成手段と、前記プラズマ生成室から前記チャンバーへ水素ラジカルを導く水素ラジカル導入路と、前記被処理体を加熱して前記有機金属化合物を分解させ、被処理体に金属膜を堆積させる加熱手段とを具備し、前記水素ラジカル導入路の内壁は絶縁体で形成されていることを特徴とする成膜装置が提供される。

【００１２】この場合に、前記有機金属化合物供給系は、前記チャンバーの上部に設けられ、前記チャンバー内へ有機金属化合物を導入する導入孔を有するシャワーヘッドを有し、前記プラズマ生成室は前記チャンバーの上方に設けられ、前記水素ラジカル導入路は前記プラズマ生成室から前記シャワーヘッドを貫通して設けられているように構成することができる。前記水素ラジカル導入路は、前記シャワーヘッドを貫通する貫通孔と、その貫通孔にはめ込まれた筒状の絶縁部材とを有する構造を採用することができる。前記水素ラジカル導入路は、プラズマ生成室側の開口面積よりも、チャンバー側の開口面積が小さくなるように形成されていることが好ましい。

【００１３】さらに、本発明の第３の観点によれば、被処理体を収容するチャンバー内へ気化された有機金属化合物を供給する工程と、水素のプラズマを形成し、形成された水素のプラズマから水素ラジカルを選択的に前記有機金属化合物に添加する工程と、前記被処理体を加熱して前記有機金属化合物を分解させ、被処理体に金属膜を堆積させる工程とを具備することを特徴とする成膜方法が提供される。

【００１４】本発明においては、チャンバー内へ有機金属化合物を導入し、チャンバー内の被処理体を加熱することにより有機金属化合物を分解して被処理体上に金属膜を成膜するに際し、チャンバー外で形成された水素のプラズマから水素ラジカルを選択的に前記チャンバーに導入するので、水素ラジカルによる反応促進作用により高い成膜速度で金属膜を形成することができるとともに、水素イオンや電子等の荷電粒子によるダメージを受けることなく良質の金属膜を得ることができる。

【００１５】具体的には、上記第２の観点のように、前記チャンバーとは別個にプラズマ生成室を設け、プラズマ生成室に電界を印加して、その中で水素のプラズマを形成し、水素ラジカル導入路によりプラズマ生成室からチャンバーへ水素ラジカルを導くに際し、水素ラジカル導入路の内壁を絶縁体で形成する。これにより、荷電粒子はプラズマ生成室内の対向電極として機能する部分に吸引されて消滅するのに対し、中性のラジカルは吸引されずに直進し、水素ラジカル導入路に至る。この場合に、水素ラジカル導入路の内壁が絶縁体で形成されているので、水素ラジカルが消滅することなくチャンバーに導入される。すなわち、水素ラジカルが選択的にチャンバーに導入される。

【００１６】

【発明の実施の形態】以下、添付図面を参照して、本発明の実施の形態について詳細に説明する。図１は、本発明の一実施態様に係るＣＶＤ成膜装置を示す断面図である。この成膜装置は、ＣＶＤによりＣｕを成膜するものであり、略円筒状をなし、真空排気可能に構成されたチャンバー１を有している。チャンバー１の中には被処理体である半導体ウエハＷを水平に支持するためのサセプター２が支持部材３により支持された状態で配置されている。サセプター２の外縁部には半導体ウエハＷをガイドするためのガイドリング４が設けられている。また、サセプター２にはヒーター５が埋め込まれており、このヒーター５は電源６から給電されることにより被処理体である半導体ウエハＷを所定の温度に加熱する。電源６にはコントローラー７が接続されており、これにより図示しない温度センサーの信号に応じてヒーター５の出力が制御される。

【００１７】チャンバー１の底壁１ｂには、排気ポート８が形成されており、この排気ポート８には排気装置９が接続されている。排気装置９によりチャンバー１内を所定の真空度まで減圧することができる。また、排気路には、自動的に排気量を制御するための自動圧力制御バルブ１０が設けられている。

【００１８】チャンバー１の天壁１ａには、シャワーヘッド１１が取り付けられている。このシャワーヘッド１１の側壁には、原料導入ポート１２が形成されており、この原料導入ポート１２には配管１３が接続されている。配管１３の他端には原料供給源１４が設けられており、この原料供給源１４からは成膜原料として液体である金属銅化合物が送出され、この金属銅化合物は配管１３の途中に設けられた気化器１５で気化されて原料導入ポート１２を介してシャワーヘッド１１内に導入される。シャワーヘッド１１は内部に空間１１ａを有しており、下壁１１ｂに多数のガス吐出孔１６を有している。したがって、配管１３を介してシャワーヘッド１１の内

部空間１１ａに導入された金属銅化合物ガスがガス吐出孔１６から半導体ウエハWに向けて吐出される。

【００１９】原料供給源２には、液体の有機銅化合物であるＣｕ（ｈｆａｃ）ＴＭＶＳまたはＣｕ（ｈｆａｃ）ＡＴＭＳが貯留されており、適宜の手段でこのような液体原料を配管１３を通って気化器１５に向けて送出する。

【００２０】シャワーヘッド１１の上方には、水素プラズマを形成するためのプラズマ生成室１７が設けられている。このプラズマ生成室１７の側壁には、水素ガス導入ポート１８が形成されており、水素ガスが水素ガス供給源１９から水素ガス導入ポート１８を介してプラズマ生成室１７に導入される。

【００２１】プラズマ生成室１７の上壁１７ａの上には渦巻き状のアンテナ２０が設けられており、このアンテナ２０には高周波電源２１が接続されている。そして、この高周波電源２１から例えば１３．５６ＭＨｚの高周波がアンテナ２０に供給されることにより、プラズマ形成室１７内には高周波電界が形成され、これにより水素ガスのプラズマが形成される。

【００２２】プラズマ生成室１７は、その底壁が上記シャワーヘッド１１の上壁１１ｃで構成されており、シャワーヘッド１１の上壁１１ｃから下壁１１ｂを貫通するように多数の水素ラジカル導入路２２が形成されている。そして、プラズマ生成室１７で生成されたプラズマの中から水素ラジカルのみが水素ラジカル導入路２２を通ってチャンバー１内に導入される。

【００２３】具体的には図２に示すように、シャワーヘッド１１を上下に貫通する多数の筒部材２３が設けられ、その内部に例えばセラミック材料からなる筒状の絶縁部材２４がはめ込まれ、絶縁部材２４の内側に水素ラジカル導入路２２が形成されている。絶縁部材２４の上端にはフランジ２４ａが形成されている。水素ラジカル導入路２２の下端、すなわちチャンバー側開口部は、上端のプラズマ生成室側開口部よりも開口面積が小さくなるように小径部２５が形成されている。この構成により、プラズマ生成室から水素ラジカルを効率良く取り込むことができるとともに、水素ラジカルのバックディフュージョンを防止することができる。

【００２４】なお、この場合の寸法は、例えば、シャワーヘッド１１の厚さが２５ｍｍ、水素ラジカル導入路２２の上端開口部の径が５ｍｍ、小径部２５の径が０．５～１ｍｍ、水素ラジカル導入路２２同士の間隔が２０ｍｍである。

【００２５】また、水素ラジカル導入路２２の入口（プラズマ生成室側開口）の周囲は絶縁物（フランジ２４ａ）で形成されているが、隣接するフランジ間の隙間には、シャワーヘッド上壁１１ｃを構成する導体（例えばアルミニウム）が露出している。

【００２６】ガス吐出口１６および水素ラジカル導入路２２のチャンバー側開口部はシャワーヘッド１１の底面において、それぞれほぼ等間隔になるように、複数の同心円状あるいはマトリクス状に配置される。さらに両者は互いに間隔を埋めるように配置され、原料ガス（有機銅化合物）、水素ラジカルとともに均一にチャンバー内に導入される。

【００２７】このように構成される成膜装置においてＣｕ膜を形成するに際しては、まず、チャンバー１内に半導体ウエハWを搬入し、サセプタ２の上に載置する。そして、排気装置９によりチャンバー１内を減圧しつつ、原料供給源１４からの液体状の有機銅化合物原料を気化器１５でガス化した原料ガスを原料導入ポート１２を介してシャワーヘッド１１内に導入し、多数のガス吐出孔１６からチャンバー１内へ導入する。

【００２８】一方、上記有機銅化合物原料の導入と同時に、プラズマ生成室１７内に水素ガス供給源１９から水素ガスを導入しつつ、高周波電源２１からアンテナ２０に高周波を印加し、プラズマ生成室１７内に水素ガスのプラズマを生成させる。

【００２９】プラズマ中には、水素イオン、電子、水素ラジカルが共存しているが、図３に示すように、荷電粒子である水素イオンおよび電子は、対向電極として機能するシャワーヘッド１１の上壁１１ｃの表面部分に吸引され消滅するが、中性である水素ラジカルは直進して水素ラジカル導入路２２に対応する部分の水素ラジカルが水素ラジカル導入路２２を通ってチャンバー内に導入される。したがって、水素ガスのプラズマの中で水素ラジカルのみが選択的にチャンバー１内に導入される。この場合に、水素ラジカル導入路２２の内壁が絶縁部材２４であるため、水素ラジカルが消滅せずにチャンバー１に導入される。また、水素ラジカル導入路２２の先端部が小径部２５となっているので、水素ラジカルのバックディフュージョンが防止され、水素ラジカルがシャワーヘッド１１の下面に衝突して消耗することを防止することができる。

【００３０】上述したように、チャンバー１内にＣｕ（ｈｆａｃ）ＴＭＶＳやＣｕ（ｈｆａｃ）ＡＴＭＳ等有機銅化合物からなる原料ガスが供給されると、半導体ウエハWはサセプタ２内に埋設されたヒーター５により、原料ガスの分解温度以上に加熱されているため、半導体ウエハWの表面において原料ガスが分解され、半導体ウエハW上にＣｕ膜が成膜される。

【００３１】この成膜の際に、上述のようにしてチャンバー１内に供給された水素ラジカルが、Ｃｕ（ｈｆａｃ）ＴＭＶＳやＣｕ（ｈｆａｃ）ＡＴＭＳ等の分解反応を促進させる。したがって、水素ラジカルの存在により成膜レートが上昇し、効率良くＣｕ膜を形成することができる。このように水素ラジカルにより反応が促進されるのは、水素ラジカルを用いない場合にＣｕまで分解されず成膜に寄与しないＣｕ成分をも分解させ、膜成分と

することができるからである。

【００３２】また、このように水素ラジカルを導入することにより反応が促進されるので、より低温で成膜することが可能となる。具体的には、従来、Ｃｕ（ｈｆａｃ）ＴＭＶＳまたはＣｕ（ｈｆａｃ）ＡＴＭＳを用いて成膜する場合に１９０℃程度に加熱する必要があったのが、水素ラジカルを導入することにより１７０℃程度にまで低下させることができる。このように低温成膜が可能なことにより、従来、Ｃｕ膜の膜厚が薄い場合に生じていたマイグレーションによる比抵抗上昇の問題を解消することができる。

【００３３】さらに、このように水素ラジカルのみを選択的にチャンバー１内に導入することができるので、形成されたＣｕ膜が水素イオンや電子などの荷電粒子によって、ダメージを受けることを防止することができる。したがって、良好な膜質のＣｕ膜を得ることができる。

【００３４】なお、本発明は上記実施形態に限定されることなく、種々変形可能である。例えば、上記実施形態では、Ｃｕ原料としてＣｕ（ｈｆａｃ）ＴＭＶＳまたはＣｕ（ｈｆａｃ）ＡＴＭＳを用いたが、これに限るものではない。

【００３５】また、本発明をＣｕのＣＶＤ成膜に適用した場合について示したが、成膜対象は必ずしもＣｕに限らず、Ａｌ等、有機金属化合物を原料としてＣＶＤを行うものであれば適用可能である。水素プラズマを形成する方法も上述の方法に限るものではない。

【００３６】さらに、上記実施形態では被処理体として半導体ウエハを用いたが、これに限らずＬＣＤ基板等、ＣＶＤで金属膜が形成される対象であればよい。

【００３７】

【発明の効果】以上述べたように、本発明によれば、チャンバー内へ有機金属化合物を導入し、チャンバー内の被処理体を加熱することにより有機金属化合物を分解して被処理体上に金属膜を成膜するに際し、チャンバー外で形成された水素のプラズマから水素ラジカルを選択的に前記チャンバーに導入して有機金属化合物に添加するので、水素ラジカルによる反応促進作用により高い成膜速度で金属膜を形成することができるとともに、水素イオンや電子等の荷電粒子によるダメージを受けることなく良質の金属膜を得ることができる。

【図面の簡単な説明】

【図１】本発明の一実施形態に係るＣＶＤ成膜装置を示す断面図。

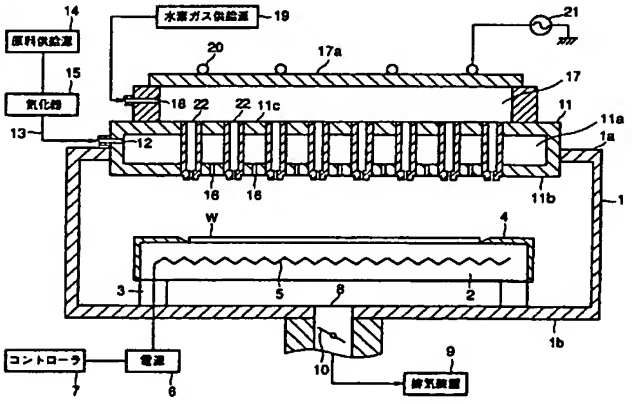
【図２】図１に示した装置の水素ラジカル導入路の配置部分を拡大して示す断面図。

【図３】プラズマ生成室からチャンバーへ水素ラジカルのみ導入される原理を説明するために、水素ラジカル導入路の配置部分を拡大して示す断面図。

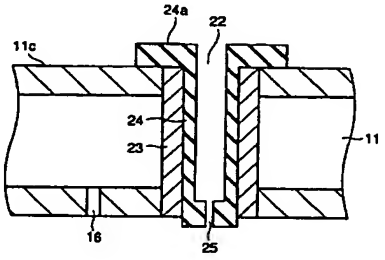
【符号の説明】

１……チャンバー
２……サセプター
５……ヒーター
１１……シャワーヘッド
１４……原料供給源
１７……水素プラズマ生成室
２１……高周波電源（プラズマ生成手段）
２２……水素ラジカル導入路
２３……絶縁部材
Ｗ……半導体ウエハ

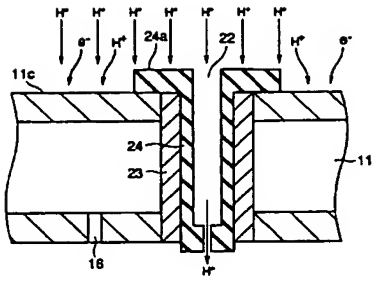
【図１】



【図２】



【図３】



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